

The documentation and process conversion measures necessary to comply with this document shall be completed by 28 February 2005.

INCH POUND

MIL-PRF-19500/505C
30 November 2004
SUPERSEDING
MIL-PRF-19500/505B
4 August 1999

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP, SILICON, POWER,
TYPES 2N6286 AND 2N6287, JAN, JANTX, AND JANTXV

This specification is approved for use by all Departments
and Agencies of the Department of Defense.

* The requirements for acquiring the product described herein shall consist of
this specification sheet and MIL-PRF-19500.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for PNP, Darlington, power transistors. Three levels of product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (similar to TO-3).

* 1.3 Maximum ratings at $T_C = +25^\circ\text{C}$ unless otherwise specified.

Type	P_T		$R_{\theta JC}$	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_B	T_J and T_{STG}
	$T_C = +25^\circ\text{C}$ (1)	$T_C = +100^\circ\text{C}$							
	<u>W</u>	<u>W</u>	<u>$^\circ\text{C/W}$</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>$^\circ\text{C}$</u>
2N6286	175	87.5	0.855	-80	-80	-7	-20	-0.5	-65 to +175
2N6287	175	87.5	0.855	-100	-100	-7	-20	-0.5	-65 to +175

(1) Derate linearly at 1.17 W/ $^\circ\text{C}$ above $T_C > +25^\circ\text{C}$.

* Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dsc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil/>.

* 1.4 Primary electrical characteristics.

Limit	h _{FE2} (1) V _{CE} = -3 V dc I _C = -10 A dc	h _{FE3} (1) V _{CE} = -3 V dc I _C = -20 A dc	V _{CE(sat)1} I _C = -20 A dc I _B = -200 mA dc	V _{CE(sat)2} I _C = -10 A dc I _B = -40 mA dc	V _{BE(sat)} I _C = -20 A dc I _B = -200 mA dc	Switching	
						t _{on}	t _{off}
Min	1,250	300	V dc	V dc	V dc	μs	μs
Max	18,000		-3.0	-2.0	-4.0	2	10

Limit	C _{obo} V _{CB} = -10 V dc I _E = 0 100 kHz ≤ f ≤ 1 MHz	h _{fe} V _{CE} = -3 V dc I _C = -10 A dc f = 1 kHz	h _{fe} V _{CE} = -3 V dc I _C = -10 A dc f = 1 MHz
Min	pF	300	8
Max	400		80

(1) Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

* 2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

* 2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

* DEPARTMENT OF DEFENSE SPECIFICATIONS

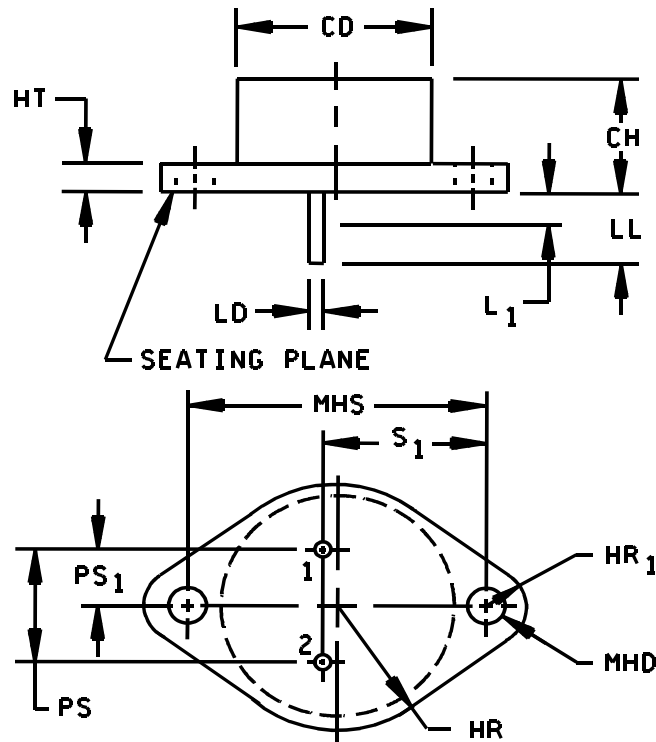
MIL-PRF-19500 - Semiconductor Devices, General Specification for.

* DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-750 - Test Methods for Semiconductor Devices.

* (Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.



NOTES:

1. Dimensions are in inches.
- * 2. Millimeters are given for general information only.
3. Body contour is optional within zone defined by CD
4. These dimensions shall be measured at points .050 (1.27 mm) to 0.055 (1.40 mm) below seating plane.
5. Both terminals.
6. At both ends.
7. Two holes.
8. Terminal 1 is the emitter, terminal 2 is base. The collector shall be electrically connected to the case.
9. LD applies between L1 and LL. Diameter is uncontrolled in L1.
- * 10. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.

* FIGURE 1. Physical dimensions (similar to TO-3).

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max			
CD		0.875		22.23	3
CH	0.250	0.360	6.35	9.14	
HR	0.495	0.525	12.57	13.34	
HR ₁	0.131	0.188	3.33	4.78	
HT	0.060	0.135	1.52	3.43	
LD	0.038	0.043	0.97	1.09	5, 9
LL	0.312	0.500	7.92	12.7	5
L ₁		0.050		1.27	5, 9
MHD	0.151	0.165	3.84	4.19	7
MHS	1.177	1.197	29.90	30.40	
PS	0.420	0.440	10.67	11.18	4
PS ₁	0.205	0.225	5.21	5.72	
S ₁	0.655	0.675	16.64	17.15	

* FIGURE 1. Physical dimensions (similar to TO-3) - Continued.

3. REQUIREMENTS

* 3.1 General. The individual item requirements shall be as specified in MIL-PRF-19500 and as modified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturers list before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500.

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 (similar to TO-3) herein.

* 3.4.1 Lead finish. Lead finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.5 Marking. Devices shall be marked in accordance with MIL-PRF-19500.

3.6 Electrical performance characteristics. Unless otherwise specified, the electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

3.7 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I.

3.8 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Screening (see 4.3).

* c. Conformance inspection (see 4.4 and tables I and II).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and herein.

* 4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table III tests, the tests specified in table III herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

MIL-PRF-19500/505C

* 4.3 Screening. Screening shall be in accordance with table IV of MIL-PRF-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table IV of MIL-PRF-19500)	Measurements
	JANTX and JANTXV levels
7	Optional.
11	I_{CEX1} and h_{FE1}
12	See 4.3.1
13	Subgroup 2 of table I herein; ΔI_{CEX1} = 100 percent of initial value or 100 μA dc, whichever is greater. Δh_{FE1} = ± 40 percent of initial value.
14	Required.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: $T_J = +162.5^\circ C \pm 12.5^\circ C$, $V_{CE} \geq -10$ V dc. NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable step of table II herein.

	<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
	B3	1037	For solder die attach: $V_{CB} \geq -10$ V dc; $T_A \leq +35^\circ C$, 2,000 cycles.
*	B3	1027	For eutectic die attach: $T_A \leq +35^\circ C$ adjust P_T to achieve $T_J = +150^\circ C$ minimum, $V_{CB} \geq -10$ V dc.
*	B5	3131	$R_{\theta JC} = 0.855^\circ C/W$ (maximum).

MIL-PRF-19500/505C

* 4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable step of table II herein.

	<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
	C2	2036	Tension: test condition A; weight = 10 lbs; time = 15 s.
*	C6	1027	For solder die attach: $V_{CB} \geq -10$ V dc; $T_A \leq 35^\circ\text{C}$, 6,000 cycles.
*	C6	1027	For eutectic die attach: $T_A \leq +35^\circ\text{C}$ adjust P_T to achieve $T_J = +150^\circ\text{C}$ minimum, $V_{CB} \geq -10$ V dc.

* 4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table IX of MIL-PRF-19500 and as specified herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2. Delta requirements shall be in accordance with the applicable step of table II herein.

4.5 Method of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

* TABLE I. Group A inspection.

Inspection 1/ 	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Breakdown voltage, collector - emitter	3011	Bias condition D; $I_C = -100$ mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	-80 -100		V dc V dc
2N6286 2N6287						
Collector - emitter cutoff current	3041	Bias condition A; $V_{BE} = +1.5$ V dc $V_{CE} = -80$ V dc $V_{CE} = -100$ V dc	I_{CEX1}		-0.5	mA dc
2N6286 2N6287						
Collector - emitter cutoff current	3041	Bias condition D $V_{CE} = -40$ V dc $V_{CE} = -50$ V dc	I_{CEO}		-1.0	mA dc
2N6286 2N6287						
Emitter - base cutoff current	3061	Bias condition D; $V_{EB} = -7$ V dc	I_{EBO}		-2.5	mA dc
Base - emitter (nonsaturated)	3066	Test condition B; $V_{CE} = -3$ V dc; $I_C = -10$ A dc	V_{BE}		-2.8	V dc
Base - emitter voltage (saturated)	3066	Test condition A; $I_C = -20$ A dc; $I_B = -200$ mA dc; pulsed (see 4.5.1)	$V_{BE(sat)}$		-4.0	V dc
Collector - emitter saturated voltage	3071	$I_C = -20$ A dc; $I_B = -200$ mA dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		-3.0	V dc
Collector - emitter saturated voltage	3071	$I_C = -10$ A dc; $I_B = -40$ mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		-2.0	V dc
Forward-current transfer ratio	3076	$V_{CE} = -3$ V dc; $I_C = -1$ A dc; pulsed (see 4.5.1)	h_{FE1}	1,500		
Forward-current transfer ratio	3076	$V_{CE} = -3$ V dc; $I_C = -10$ A dc; pulsed (see 4.5.1)	h_{FE2}	1,250	18,000	

See footnote at end of table.

* TABLE I. Group A inspection - Continued.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued						
Forward-current transfer ratio	3076	$V_{CE} = -3 \text{ V dc}; I_C = -20 \text{ A dc};$ pulsed (see 4.5.1)	h_{FE3}	300		
<u>Subgroup 3</u>						
High-temperature operation:		$T_A = +150^\circ\text{C}$				
Collector - emitter cutoff current	3041	Bias condition A; $V_{BE} = +1.5 \text{ V dc};$	I_{CEX2}		-5.0	mA dc
2N6286 2N6287		$V_{CE} = -80 \text{ V dc}$ $V_{CE} = -100 \text{ V dc}$				
Collector - emitter saturated voltage	3071	$I_C = -10 \text{ A dc}; I_B = -40 \text{ mA dc};$ pulsed (see 4.5.1)	$V_{CE(sat)3}$		-2.0	V dc
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = -3 \text{ V dc}; I_C = -10 \text{ A dc};$ pulsed (see 4.5.1)	h_{FE4}	150		
<u>Subgroup 4</u>						
* Pulse response:	3251	Test condition A, except test circuit and pulse requirements in accordance with figure 2.				
Turn-on time		$V_{CC} = -30 \text{ V dc}; I_C = -10 \text{ A dc};$ $I_B = -40 \text{ mA dc}$	t_{on}		2.0	μs
Turn-off time		$V_{CC} = -30 \text{ V dc}; I_C = -10 \text{ A dc};$ $I_{B1} = I_{B2} = -40 \text{ mA dc}$ (see figure 2)	t_{off}		10	μs
Magnitude of common-emitter small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = -3 \text{ V dc}; I_C = -10 \text{ A dc};$ $f = 1.0 \text{ MHz}$	$ h_{fe} $	8	80	
* Small-signal short-circuit forward-current transfer ratio	3206	$V_{CE} = -3 \text{ V dc}; I_C = -10 \text{ A dc}$ $f = 1.0 \text{ kHz}$	h_{fe}	300		
Open circuit output capacitance	3236	$V_{CB} = -10 \text{ V dc}; I_E = 0;$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{obo}		400	pF

See footnote at end of table.

* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u>						
Safe operating area (continuous dc)	3051	$T_C = +25^\circ\text{C}$; $t = 1 \text{ s}$; 1 cycle; (see figure 3)				
<u>Test 1</u>		$V_{CE} = -8.75 \text{ V dc}$; $I_C = -20 \text{ A dc}$				
<u>Test 2</u>		$V_{CE} = -30 \text{ V dc}$; $I_C = -5.8 \text{ A dc}$				
<u>Test 3</u>						
2N6286		$V_{CE} = -80 \text{ V dc}$; $I_C = -100 \text{ mA dc}$				
2N6287		$V_{CE} = -100 \text{ V dc}$; $I_C = -100 \text{ mA dc}$				
Electrical measurements		See table I, subgroup 2				
Safe operating area (switching)	3053	Load condition C; (unclamped inductive load); (see figure 4) $T_A = +25^\circ\text{C}$; $R_s \leq 0.1 \Omega$; $t_r + t_f \leq 15 \text{ ns}$; duty cycle ≤ 2 percent				
<u>Test 1</u>		$t_p = 80 \mu\text{s}$; (vary to obtain I_C); $R_{BB1} \geq 50 \Omega$; $V_{BB1} \geq -10 \text{ V dc}$; $R_{BB2} = \infty$; $V_{BB2} = 0$; $I_C = -20 \text{ A dc}$; $V_{CC} \geq -50 \text{ V dc}$; The coil used shall provide a minimum inductance of 1 mH at 20 A. (For reference only; two coils in parallel (Super Electric Corporation type S16884 or equivalent).)				
<u>Test 2</u>		$t_p = 1 \text{ ms}$; (vary to obtain I_C); $R_{BB1} \geq 50 \Omega$; $V_{BB1} \geq -10 \text{ V dc}$; $R_{BB2} = \infty$; $V_{BB2} = 0$; $I_C = -500 \text{ mA dc}$; $V_{CC} \geq -50 \text{ V dc}$; The coil used shall provide a minimum inductance of 100 mH at 500 mA. (For reference only; two coils in series, 80 mH and 20 mH windings (Triad C-48u or equivalent).)				

See footnote at end of table.

* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u> - Continued						
Electrical measurements		See table I, subgroup 2				
Safe operating area (switching)	3053	Load condition B; (clamped inductive load); $T_A = +25^\circ\text{C}$; $R_s = 0.1\ \Omega$; $t_r + t_f \leq 1.0\ \mu\text{s}$; duty cycle ≤ 2 percent; $t_p = 1\ \text{ms}$ (vary to obtain I_C); $R_{BB1} = 50\ \Omega$; $V_{BB1} = -10\ \text{V dc}$; $R_{BB2} = 100\ \Omega$; $V_{BB2} = +1.5\ \text{V dc}$; $V_{CC} = -25\ \text{V dc}$; $I_C = -20\ \text{A dc}$; $R_L \leq 2\ \Omega$; $L = 5\ \text{mH}$; (Four coils in parallel, 20 mH windings (Triad C-48u or equivalent)).				
2N6286		Clamp voltage = 80 +0, -5 V dc				
2N6287		Clamp voltage = 100 +0, -5 V dc Device fails if clamp voltage is not reached				
Electrical measurements		See table I, subgroup 2				
<u>Subgroups 6 and 7</u>						
Not applicable						

1/ For sampling plan, see MIL-PRF-19500.

MIL-PRF-19500/505C

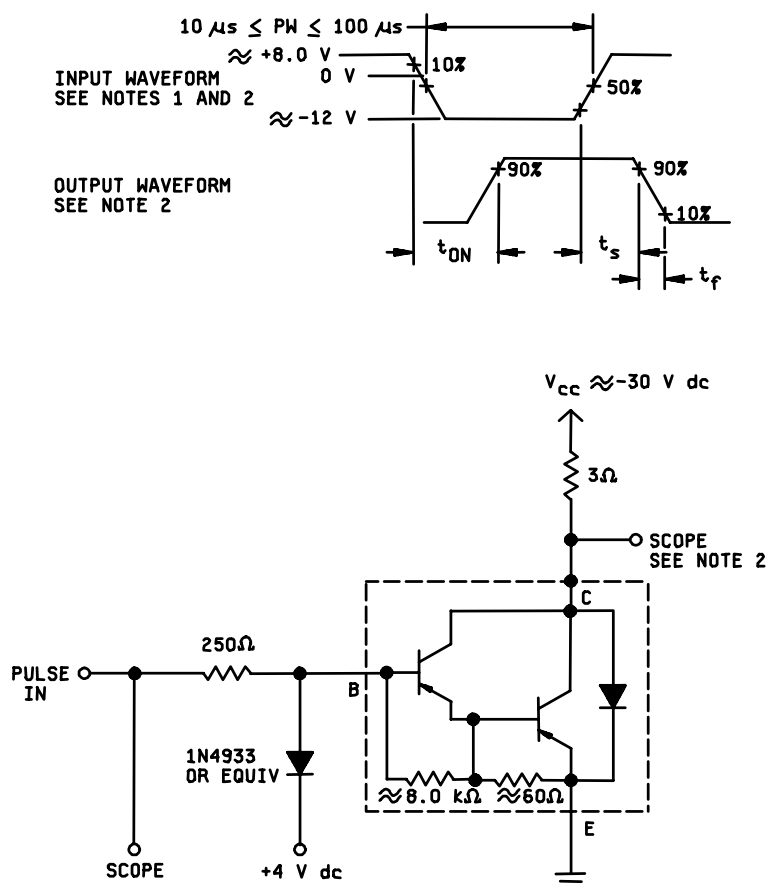
* TABLE II. Group B and C delta measurements. 1/ 2/ 3/

Step	Inspection	MIL-STD-750		Symbol	Limit
		Method	Conditions		
1.	Forward current transfer ratio	3076	$V_{CE} = -3 \text{ V dc}; I_C = -1 \text{ A dc};$ pulsed (see 4.5.1)	Δh_{FE1}	± 40 percent change from initial reading.

- 1/ The delta measurements for table VIb (JAN, JANTX and JANTXV) are: Subgroups 3 and 6 of MIL-PRF-19500, see table II, step 1 above.
- 2/ The delta measurement for table VII is: Subgroup 6 of MIL-PRF-19500, see table II, step 1 above.
- 3/ The delta measurements for table IX of MIL-PRF-19500 are: Subgroups 1 and 2, see table II, step 1 above.

* TABLE III. Group E inspection (all quality levels) - for qualification or re-qualification only.

Inspection	MIL-STD-750		Qualification and large lot quality conformance inspection
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling	1051	Test condition C, 500 cycles.	
Hermetic seal	1071	Test conditions G or H	
Fine leak		Test conditions C or D	
Gross leak			
End-point electrical measurements		See table I, subgroup 2 and table II herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	Intermittent operation life: $V_{CB} \geq 10$ V dc, 6,000 cycles.	
End-point electrical measurements		See table I, subgroup 2 and table II herein.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		Each supplier shall submit their qual-lot average and design maximum thermal impedance curves to the qualifying activity. In addition, the optimal test conditions and $Z_{\theta JX}$ limit shall be provided to the qualifying activity in the qualification report.	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 6</u>			3 devices
ESD	1020	Testing not required for devices listed as class 3. Testing required for nonsensitive listing to prove capability.	
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B.	



NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics: $t_r \leq 20$ ns, $t_f \leq 20$ ns, $Z_{out} = 50 \Omega$, PW = 23 μ s, duty cycle ≤ 2 percent.
2. The output waveform is monitored on a sampling oscilloscope with $Z_{in} \geq 20$ M Ω , $C_{in} \leq 11.5$ pF, $t_r \leq 2$ ns.
3. Resistors shall be noninductive types.
4. The dc power supplies may require additional by-passing in order to minimize ringing.

FIGURE 2. Pulse response test circuit.

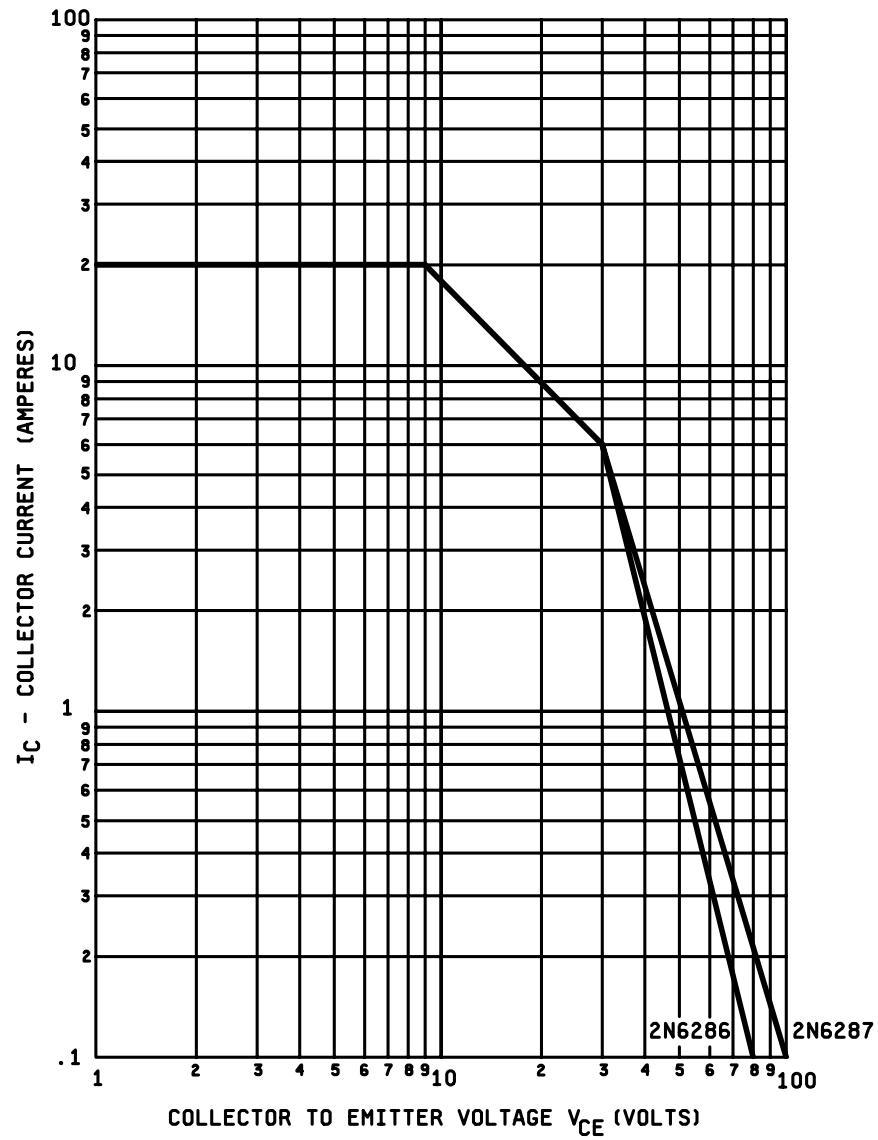


FIGURE 3. Maximum safe operating area (continuous dc).

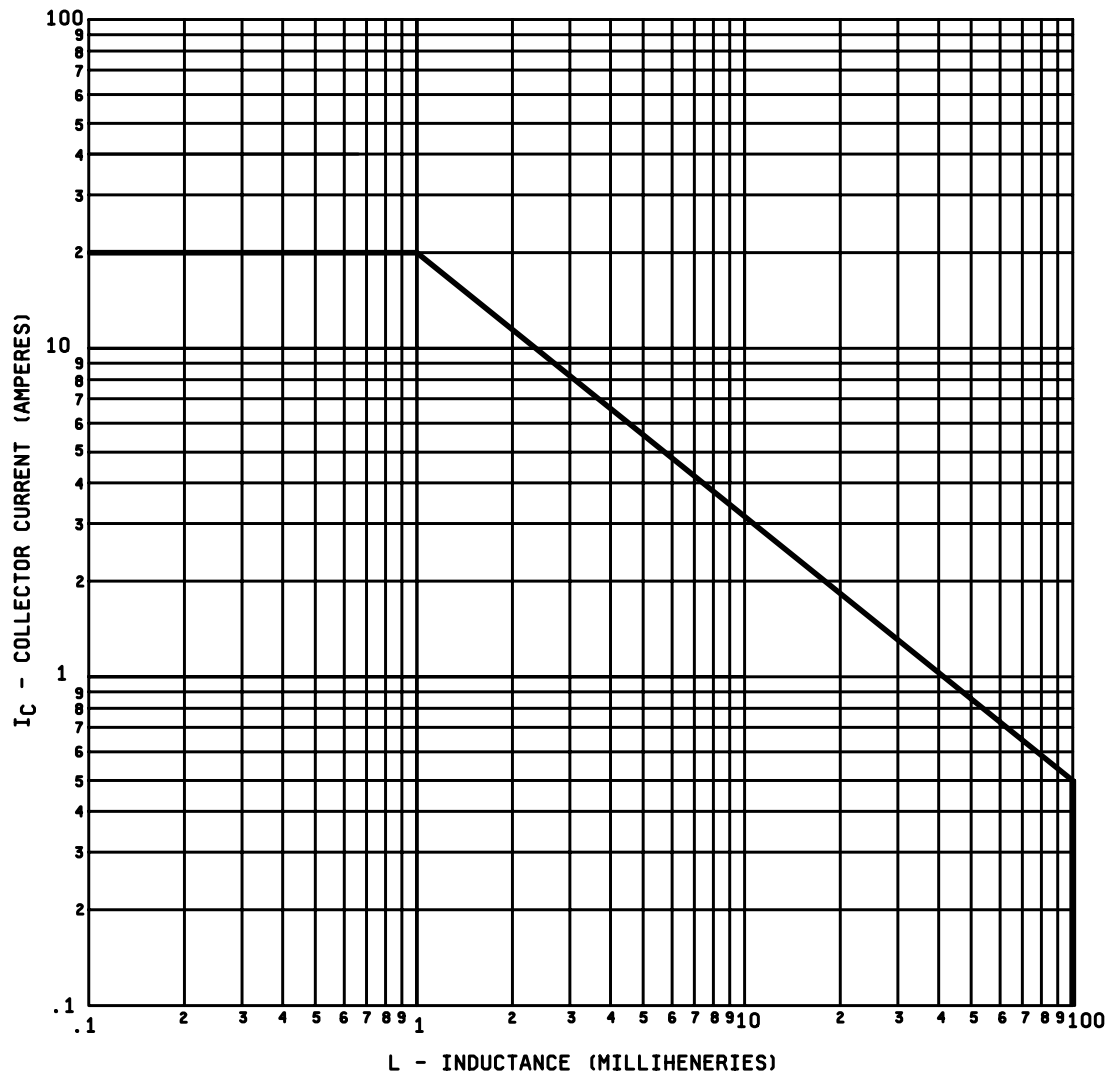


FIGURE 4. Safe operating area for switching between saturation and cutoff (unclamped inductive load).

5. PACKAGING

* 5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The notes specified in MIL-PRF-19500 are applicable to this specification.

* 6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1).
- d. Product assurance level and type designator.

* 6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil.

6.4 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodian:
Air Force - 11
NASA - NA
DLA - CC

Preparing activity:
DLA - CC
(Project 5961-2890)

Review activities:
Air Force - 19, 99

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